Eco-profiles and Environmental Product Declarations of the European Plastics Manufacturers

Ethylene, Propylene, Butadiene, Pyrolysis Gasoline, Ethylene Oxide (EO), Ethylene Glycols (MEG, DEG, TEG)

PlasticsEurope

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PlasticsEurope
Association of Plastics Manufacturers

Environmental Product Declaration

This Environmental Product Declaration (EPD) is based upon life cycle inventory (LCI) data from PlasticsEurope's Eco-profile programme. It has been prepared according to **PlasticsEurope's Eco-profiles and Environmental Declarations – LCI Methodology and PCR for Uncompounded Polymer Resins and Reactive Polymer Precursors** (PCR version 2.0, April 2011). EPDs provide environmental performance data, but no information on the economic and social aspects which would be necessary for a complete sustainability assessment. Further, they do not imply a value judgment between environmental criteria.
This EPD describes the production of the polymer precursors Ethylene, Propylene, Butadiene, Pyrolysis Gasoline, Ethylene Oxide (EO) and Ethylene Glycols (EG) from cradle to gate (from crude oil extraction to product at plant). **Please keep in mind that comparisons cannot be made on the level of the precursors**: it is necessary to consider the full life cycle of an application in order to compare the performance of different materials and the effects of relevant life cycle parameters. This EPD is intended to be used by member companies, to support product-orientated environmental management; by users of plastics, as a building block of life cycle assessment (LCA) studies of individual products; and by other interested parties, as a source of life cycle information.

Meta Data

Data Owner	PlasticsEurope & CEFIC/APPE
LCA Practitioner	IFEU – Institut für Energie- und Umweltforschung Heidelberg
Programme Owner	PlasticsEurope aisbl
Programme Manager, Reviewer	DEKRA Consulting GmbH
Number of plants included in data collection	50 steam cracker units; complemented by desktop study of subsequent steps.
Representativeness	Production in EU27 countries + Norway
Reference year	2009
Year of data collection and calculation	2007–2010
Expected temporal validity	2014
Cut-offs	None
Data Quality	Good
Allocation method	mass allocation, except for: stoichiometric allocation for glycol process, energy allocation for refinery

Description of the Product and the Production Process

This Eco-Profile and EPD represents the average industrial production of several petrochemical polymer precursors from cradle to gate.

Production Process

The model for this Eco-profile comprises extraction and refinery of crude oil and natural gas, steam cracking of longer, saturated hydrocarbons into lower olefins, ethylene oxidation, and ethylene glycol production. Impacts related to abnormal process conditions (like accidents) are not considered in this study.

Data Sources and Allocation

The modelling of steam cracking and petroleum refinery is based on confidential process and emission data from several sites. Additionally, recent data for energy consumption, feedstock mix and CO_2 emissions have been provided by APPE for the majority of European (EU27+CH+NOR) steam crackers. Representative literature data has been used to fill gaps where no primary data were available and to cross-check primary data. The glycol process has been allocated by stoichiometric principles; the petroleum refinery has been allocated by energy; other processes have been allocated by mass as a default.

Use Phase and End-of-Life Management

The disposal of waste from production processes is considered within the system boundaries this Eco-profile. However, the use phase and end-of-life processes are outside the system boundaries of this cradle-to-gate system: since the objects of this study are polymer precursors with a broad range of applications, even a qualitative discussion of these aspects was deemed inappropriate.

Environmental Performance

The tables below show the environmental performance indicators associated with the production of 1 kg of each respective polymer precursor (the following abbreviations are used – EO: Ethylene oxide; MEG: Monoethylenegelycol; DEG: Diethyleneglycol; TEG: Triethyleneglycol; Pygas: pyrolysis gasoline).

Input Parameters

Indicator	Unit	Ethylene	Propylene	Butadiene	Pygas	EO	MEG	DEG	TEG
Non-renewable energy resources[1)]									
• Fuel energy	MJ	24.4	24.4	34.2	14.8	33.7	27.1	32.2	34.2
• Feedstock energy	MJ	47.8	47.8	49.6	50.2	30.4	21.6	25.3	26.8
Renewable energy resources (biomass)[1)]									
• Fuel energy	MJ	0.3	0.3	0.6	0.2	1.2	1.3	1.5	1.6
• Feedstock energy	MJ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Abiotic Depletion Potential									
• Elements	kg Sb eq	$2.7x10^{-8}$	$2.7x10^{-8}$	$3.5x10^{-8}$	$2.2x10^{-8}$	$2.8x10^{-8}$	$2.2x10^{-8}$	$2.6x10^{-8}$	$2.8x10^{-8}$
• Fossil fuels	MJ	66.9	66.9	76.7	60.4	56.8	42.1	49.7	52.7
Renewable materials (biomass)	kg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water use	kg	19.1	19.1	78.4	14.2	38.5	43.2	51.0	54.1
• for process	kg	1.9	1.9	2.5	1.6	2.3	7.8	9.2	9.8
• for cooling	kg	14.4	14.4	73.2	10.1	34.0	33.8	39.9	42.3
• unspecified	kg	2.8	2.8	2.8	2.5	2.2	1.6	1.9	2.0

[1)] Calculated as upper heating value (UHV)

Output Parameters

Indicator	Unit	Ethylene	Propylene	Butadiene	Pygas	EO	MEG	DEG	TEG
GWP	kg CO_2 eq	1.44	1.44	1.98	1.02	2.00	1.58	1.86	1.97
ODP	g CFC-11 eq	$2.7x10^{-4}$	$2.7x10^{-4}$	$4.8x10^{-4}$	$2.2x10^{-4}$	$5.0x10^{-4}$	$4.9x10^{-4}$	$5.7x10^{-4}$	$6.1x10^{-4}$
AP	g SO_2 eq	3.52	3.52	4.14	3.00	3.76	3.10	3.67	3.89
POCP	g Ethene eq	0.33	0.33	0.36	0.24	0.53	0.40	0.47	0.50
EP	g PO_4 eq	1.08	1.08	1.16	0.95	0.94	0.72	0.85	0.90
Dust/particulate matter	g PM10	0.21	0.21	0.24	0.18	0.23	0.19	0.23	0.24
Total particulate matter[2)]	g PM10 eq	3.33	3.33	3.91	2.81	3.45	2.81	3.32	3.52
Waste	kg	0.0053	0.0053	0.0055	0.0031	0.0042	0.0030	0.0036	0.0038
• Non-hazardous	kg	0.0024	0.0024	0.0025	0.0014	0.0019	0.0014	0.0016	0.0017
• Hazardous	kg	0.00028	0.00028	0.00038	0.00017	0.00022	0.00016	0.00019	0.00020
• Unspecified	kg	0.0026	0.0026	0.0026	0.0015	0.0021	0.0015	0.0017	0.0018

[2)] Including secondary PM10

Additional Environmental and Health Information

At the end of 1998, the International Council of Chemical Associations (ICCA) launched a voluntary global initiative to accelerate the process of data collection and hazard assessment for High Production Volume (HPV) chemicals in the frame of the OECD SIDS (Screening Information Data Set) programme. On the ICCA/HPV list (1,325 chemicals), the percentage of commitment for APPE-related products reached 91.5 %, the general chemical industry percentage of commitment being 70.3 %.

Additional Technical Information

Lower olefins are petrochemical derivatives produced by cracking feedstocks from raw materials such as natural gas and crude oil. The main olefin products are ethylene, propylene, butadiene and C4 derivatives. These petrochemical derivatives are used to produce plastics, as chemical intermediates, and, in some cases, as industrial solvents. Ethylene oxide alone or in combination with other inert gases such as carbon dioxide and nitrogen is used to sterilise instruments for the healthcare, publication and wood products sectors. Ethylene oxide is also used in other industries where heat-sensitive goods are sterilised and in the manufacture of choline chloride, glycol ethers and polyglycols. Other minor uses world-wide include its application in the manufacture of rocket propellant and petroleum demulsifiers.

The major use of ethylene oxide is in the manufacture of ethylene glycol, which is used as a chemical intermediate in the manufacture of polyesters for fibres, films, bottles etc. with a further 25% used as antifreeze in engine coolants. Ethylene glycol is also used as a plasticiser for adhesives, as a softener for cellulose film, and as solvents in paint, printing inks and adhesives. Ethylene glycol has also specialised applications as glycoborates in electrolytic condensers, glycol dinitrate in explosives, various heat transfer applications, hydraulic brake fluids, humectant in inks, antifreeze and plasticiser in paints and to reduce gelling of medium oil alkyds based on pentaerythritol.

Additional Economic Information

The chemical industry is an energy-intensive industry in a highly competitive global environment. On average, about 9% of total production costs are due to energy use. For some petrochemicals, this ratio can rise up to 75%. Because of this, the chemical industry has already invested over many decades in energy efficiency improvement. Whilst energy saving has been primarily economically motivated, the EU chemical industry is increasingly recognising the implications of potential actions to reduce greenhouse gas (GHG) emissions and the effects that these might have on their operations. In line with its Responsible Care approach to environment, health and safety, the EU chemical industry has taken early actions through innovation and better management to improve the energy efficiency of its processes. These actions have achieved an improvement in specific energy consumption of 30% since 1990.

Information

Data Owner

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Programme Manager & Reviewer
DEKRA Consulting GmbH
This Environmental Product Declaration has been reviewed by DEKRA Consulting GmbH. It was approved according to the Product Category Rules PCR version 2.0 (2011-04) and ISO 14025:2006.
Registration number: PlasticsEurope 2012-003, valid until 30 November 2015 (date of next revalidation review).

Programme Owner

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For copies of this EPD, for the underlying LCI data (Eco-profile); and for additional information, please refer to http://www.plasticseurope.org/.

References

- PlasticsEurope: Eco-profiles and environmental declarations – LCI methodology and PCR for uncompounded polymer resins and reactive polymer precursor (version 2.0, April 2011).

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